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ABSTRACT

The purpose of this study was to relate leg strength and power to alpine skiing success as measured by FIS points. Isometric leg strength was represented by the knee extension test described by Clarke. Leg power was measured by the vertical jump test and the Margaria-Kalamen stair run. Results in the strength and power tests were correlated with the FIS points in three different alpine events (downhill, slalom, and giant slalom). Subjects consisted of 26 female and 28 male participants in a national junior alpine development camp. For the entire group, a significant correlation coefficient was observed between FIS points in the giant slalom event and total leg strength. For females, significant correlations were found between success in the giant slalom and leg strength, stair power, and vertical jump. For males, significant relationships were seen between vertical jump work and FIS points in the downhill and giant slalom event. (Supportive tables are included as appendixes.) (Author/JA)

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The Relationships Among Leg Strength, Leg Power and Alpine Skiing Success

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The purpose of this investigation was to determine what relationships exist among leg strength, leg power and alpine skiing success. Pearson product-moment correlation coeficients were used to examine the above associations. Twenty-six (26) females (mean age of 17.2 years) and 28 males (mean age of 18.5 years) were tested for leg strength and power at a national junior alpine skiing development camp in Mt. Hood Oregon, during June, 1972. These individuals, all who had under 100 FIS points for their events, represented the best junior alpine ski racers for the 1971-72 season. Leg strength was represented as the maximum isometric quadricep contraction in the knee extension test described by Clarke (1966). Leg power was tested by the Margaria-Kalmen stair run described in Mathews (1970) and by the vertical jump test represented as work accomplished.

Alpine skiing success was determined by the FIS rating points accumulated by the skiers during the 1971-72 season (which had ended just prior to the junior development camp). Considering all skiers, 24 had less than 100 points in the downhill event (10 female, 14 male). Forty skiers had less than 100 points in the slalom event (21 female, 19 male). Forty-two (42) skiers had less than 100 points in the giant slalom event (23 female, 19 male). The total points for the season in each of these events were correlated with the leg strength and power scores.

The description of subjects appears in Table I. The % fat for the males was estimated using Pascale's (1958) three skinfold sites and Brozek and Key's (1963) density tc fat conversion. The % fat for the females was estimated using Sloan's (1962) two skinfold sites and Brozek and Key's (1963) density to fat conversion.

The strength, power, and FIS point results are presented in Table II. These items plus age, height, and weight were intercorrelated to examine the relationships among them. The main focus will be upon total leg strength, stair power in kgm/min., vertical jump work in ft., lbs., and the three ski events.

The intercorrelation results, using all subjects, are presented in Table III/ It is interesting to note the rather low correlations existing between total leg strength and downhill and slalom skiing events (-.28 and -.10 respectively). A correlation of -.35 between the giant slalom event and total leg strength, however, is statistically significant (.05 level), and this may be considered a definite but small relationship. Likewise, very low correlations were observed between stair power measurements and the three skiing events: -.16, -.11, and -.25; downhill, slalom, and giant slalom, respectively. Correlation coefficients relating vertical jump work and the skiing events (-.33, -.18, and -.30) were slightly higher than the stair power associations with the events (the GS and jump work being significantly related). It is also interesting to note in Table III the highly significant (.01 level) correlations of age to performance in all three skiing events (-.56, -.62, -.66). This may be considered as showing a substantial relationship between age and skiing success.

Iin Tables IV and V are presented the intercorrelations for females and males examined separately. In Table IV, the correlations between the giant slalom event

and strength and power measures are significant (-.51, -.49, -.48, total leg strenght, stair power, and vertical jump work, respectively). Also highly significant (.01 level) are the correlations between weight and performance in the giant slalom-(-.66) and height to success in the GS (-.50, significant at .05 level).

In male skiers vertical jump work correlates highly with performance in both the downhill and giant slalom events (Table V).

In summary, leg strenght, body weight, and vertical jump work are moderately but significantly related to the giant slalom event considering both male and female skiers combined. Age is definitely related to alpine skiing success in all three events. Examining just the female junior skiers, all leg strength and power measurements were significantly related to the giant slalom event. Height and weight were also moderately but significantly related to the giant slalom performance. Considering just the male skiers, the vertical jump work measurement was significantly related to the downhill and giant slalom events.

In conclusion, for female junior alpine skiers, the leg strength and power measurements are only related to success in the giant slalom event. For male junior skiers, only the leg power measurements of vertical jump work is related to the downhill and the giant slalom events.

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P.S. Subsequent analyses of data have shown that all strength and power scores were significantly related to the ski events when 97 juniors with less than 300 FIS points were used (Table VI). For both male and female skiers, leg strength is moderately related to all three events. The stair run power was related to the downhill for males only. The vertical jump test was related to the ski events for both males and females (Tables VII and VIII).

In conclusion, the first analyses of data reveals that ski success is not only related to just physical measurements but probably to psychological factors in the very best junior racers. When most junior racers are considered the physical measurements become even more important factors relating to success.

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Table I
Description of Subjects

	Male		Female	
Variable	Mean	± Std. Dev.	Mean	± Std. Dev.
Age (yrs)	18.5	1.6	17.2	2.0
Height (ins)	70.1	2.2	64.7	2.2
Weight (lbs)	160.8	12.4	128.9	14.5
LBW (lbs)	143.8	10.5	97.1	8.3
Body Fat (%)	10.6	1.4	24.4	3.5
Thigh Girth (cm)	56.3	2.1	54.6	3.2
Claf Girth (cm)	36.7	1.5	34.2	1.9

Table II
Strength, Power, and FIS Point Results

	Male		Female	
Variable	Mean ± Std. Dev.		Mean ± Std. Dev.	
Rt. Leg (lbs)	264	48	204	49
Lt. Leg (lbs)	275	57	210	38
Total Leg (lbs)	536	102	414	73
Vertical Jump (ins)	22.9	2.8	17.4	1.8
VJ Work (ft. lbs)	302	46	183	21
Stair Run Time (sec)	.571	.049	.662	.066
Stair Run Power (kgm/sec)	143	18	88	12
Downhill FIS points	54.1	18.5	52.2	19.9
Slalom FIS points	66.9	20.7	69.4	23.4
Giant Slalom FIS points	60.3	22.2	64.0	22.1

Table III
Intercorrelation Matrix for All Skiers

	1	2	3	4	5	6	7	8	9	10	11	12	13
1	1.00	.54	.51	.43	.42	.45	-.27	.45	.86	.48	-.56	-.62	-.66
2		1.00	.91	.65	.59	.63	-.67	.87	.61	.83	-.24	-.10	-.21
3			1.00	.67	.64	.66	-.62	.90	.56	.84	-.27	-.14	-.35
4				1.00	.88	.97	-.52	.64	.52	.66	-.29	-.16	-.34
5					1.00	.97	-.50	.62	.57	.69	-.24	-.07	-.30
6						1.00	-.51	.64	.55	.69	-.28	-.10	-.35
7							1.00	-.89	-.76	-.78	.03	.06	.11
8								1.00	.74	.91	-.16	-.11	-.25
9									1.00	.92	-.26	-.16	-.21
10										1.00	-.33	-.18	-.30
11											1.00	.51	.49
12												1.00	.86
13													1.00

Variable 11, r = .40, df = 22, $p < .05$
Varialbe 12, r = .31, df = 38, $p < .05$
Varialbe 13, r = .30, df = 40, $p < .05$

1. Age (yrs)
2. Height (ins)
3. Weight (lbs)
4. Rt. Leg (lbs)
5. Lt. Leg (lbs)
6. Tot. Leg (lbs)
7. Stair time (secs)
8. Stair power (kgm/sec)
9. Vert. Jump (ins)
10. Vert. Jump (ft. lbs)
11. FIS Downhill (pts)
12. FIS Slalom (pts)
13. FIS Giant Slalom (pts)

Table IV
Intercorrelation Matrix for Female Skiers

	1	2	3	4	5	6	7	8	9	10	11	12	13
1	1.00	.57	.50	.26	.27	.28	.25	.20	-.20	.28	-.58	-.73	-.79
2		1.00	.74	.50	.46	.52	.06	.56	-.10	.57	-.21	-.26	-.50
3			1.00	.55	.52	.58	.22	.66	-.27	.65	-.20	-.33	-.66
4				1.00	.74	.94	-.20	.65	-.17	.39	-.35	-.27	-.46
5					1.00	.93	-.14	.57	-.03	.48	.01	-.08	-.48
6						1.00	-.18	.65	-.11	.47	-.21	-.19	-.51
7							1.00	-.58	-.37	-.09	.21	-.05	.00
8								1.00	.07	.62	-.33	-.26	-.49
9									1.00	.54	-.47	.12	.03
10										1.00	-.50	-.18	-.48
11											1.00	.64	.64
12												1.00	.83
13													1.00

Variable 11, r = .53, df = 12, $p < .05$
Variable 12, r = .46, df = 17, $p < .05$
Variable 13, r = .46, df = 17, $p < .05$

1. Age (yrs)
2. Height (ins)
3. Weight (lbs)
4. Rt. Leg (lbs)
5. Lt. Leg (lbs)
6. Tot. Leg (lbs)
7. Stair time (secs)
8. Stair power (kgm/sec)
9. Vert. Jump (ins)
10. Vert. Jump (ft. lbs)
11. FIS Downhill (pts)
12. FIS Slalom (pts)
13. FIS Giant Slalom (pts)

Table V
Intercorrelation Matrix for Male Skiers

	1	2	3	4	5	6	7	8	9	10	11	12	13
1	1.00	.34	.31	.37	.37	.41	-.52	.46	.50	.54	-.59	-.54	-.57
2		1.00	.83	.32	.20	.26	-.30	.69	.14	.51	-.54	.08	.13
3			1.00	.35	.31	.33	-.31	.82	.11	.58	-.60	.11	-.24
4				1.00	.88	.96	.06	.20	.34	.45	-.27	.05	-.12
5					1.00	.97	.04	.21	.40	.49	-.44	-.02	-.16
6						1.00	.06	.21	.39	.49	-.38	.04	-.17
7							1.00	-.68	-.53	-.56	.01	.34	.35
8								1.00	.34	.67	-.40	-.06	-.29
9									1.00	.87	-.34	-.44	-.50
10										1.00	-.64	-.38	-.56
11											1.00	.25	.13
12												1.00	.90
13													1.00

Variable 11, r = .63, df = 8, $p < .05$
Variable 12, r = .43, df = 19, $p < .05$
Variable 13, r = .41, df = 21, $p < .05$

1. Age (yrs)
2. Height (ins)
3. Weight (lbs)
4. Rt. Leg (lbs)
5. Lt. Leg (lbs)
6. Tot. Leg (lbs)
7. Stair time (secs)
8. Stair power (kgm/sec)
9. Vert. Jump (ins)
10. Vert. Jump (ft. lbs)
11. FIS Downhill (pts)
12. FIS Slalom (pts)
13. FIS Giant Slalom (pts)

Table VI
Intercorrelation Matrix for ALL Skiers, N = 97

	1	2	3	4	5	6	7	8	9	10	11	12	13
1	1.00	.54	.54	.39	.41	.42	-.21	.46	.29	.49	-.52	-.54	-.56
2		1.00	.90	.61	.54	.59	-.52	.82	.45	.76	-.36	-.35	-.39
3			1.00	.63	.57	.62	-.53	.88	.43	.80	-.43	-.33	-.43
4				1.00	.82	.95	-.34	.55	.47	.65	-.48	-.40	-.45
5					1.00	.96	-.30	.50	.52	.66	-.50	-.39	-.45
6						1.00	-.33	.54	.51	.68	-.52	-.40	-.47
7							1.00	-.85	-.51	-.66	.27	.20	.17
8								1.00	.59	.85	-.40	-.30	-.35
9									1.00	.88	-.31	-.36	-.40
10										1.00	-.44	-.40	-.48
11											1.00	.75	.83
12												1.00	.89
13													1.00

Variable 11, r = .23, df = 74, $p < .05$
Variable 12, r = .22, df = 80, $p < .05$
Variable 13, r = .22, df = 82, $p < .05$

1. Age (yrs)
2. Height (ins)
3. Weight (lbs)
4. Rt. Leg (lbs)
5. Lt. Leg (lbs)
6. Tot. Leg (lbs)
7. Stair time (secs)
8. Stair power (kgm/sec)
9. Vert. Jump (ins)
10. Vert. Jump (ft. lbs)
11. FIS Downhill (pts)
12. FIS Slalom (pts)
13. FIS Giant Slalom (pts)

Table VII
Intercorrelation for Females, N = 46

	1	2	3	4	5	6	7	8	9	10	11	12	13
1	1.00	.49	.51	.21	.26	.26	.31	.16	-.21	.24	-.41	-.46	-.44
2		1.00	.77	.44	.34	.43	.12	.52	-.22	.47	-.14	-.26	-.31
3			1.00	.45	.43	.47	.20	.65	-.31	.57	-.25	-.25	-.29
4				1.00	.71	.93	-.06	.45	-.07	.34	-.43	-.36	-.42
5					1.00	.92	-.08	.45	.16	.53	-.46	-.36	-.48
6						1.00	-.08	.49	.04	.46	-.47	-.38	-.48
7							1.00	-.61	-.40	-.15	-.08	-.02	-.15
8								1.00	.06	.60	-.14	-.17	-.12
9									1.00	.60	-.01	-.13	-.14
10										1.00	-.24	-.31	-.39
11											1.00	.75	.83
12												1.00	.87
13													1.00

Variable 11, $r = .32$, $df = 37$, $p < .05$
Variable 12, $r = .30$, $df = 42$, $p < .05$
Variable 13, $r = .29$, $df = 44$, $p < .05$

1. Age (yrs)
2. Height (ins)
3. Weight (lbs)
4. Rt. Leg (lbs)
5. Lt. Leg (lbs)
6. Tot. Leg (lbs)
7. Stair time (secs)
8. Stair power (kgm/sec)
9. Vert. Jump (ins)
10. Vert. Jump (ft. lbs)
11. FIS Downhill (pts)
12. FIS Slalom (pts)
13. FIS Giant Slalom (pts)

Table VIII
Intercorrelation for Males, N = 51

	1	2	3	4	5	6	7	8	9	10	11	12	13
1	1.00	.46	.48	.38	.42	.43	-.08	.33	.31	.31	-.57	-.59	-.71
2		1.00	.83	.50	.44	.48	-.08	.20	.12	.41	-.25	-.28	-.26
3			1.00	.53	.48	.52	-.17	.25	.11	.48	-.35	-.22	-.47
4				1.00	.85	.95	-.04	.35	.46	.65	-.35	-.25	-.35
5					1.00	.97	-.03	.33	.48	.66	-.48	-.32	-.39
6						1.00	-.02	.35	.49	.48	-.46	-.29	-.39
7							1.00	.49	-.12	-.56	.25	.27	.25
8								1.00	.11	-.42	-.38	.06	-.05
9									1.00	.66	-.29	-.51	-.61
10										1.00	-.47	-.48	-.58
11											1.00	.61	.75
12												1.00	.87
13													1.00

Variable 11, r = .33, df = 35, $p < .05$
Variable 12, r = .32, df = 36, $p < .05$
Variable 13, r = .32, df = 36, $p < .05$

1. Age (yrs)
2. Height (ins)
3. Weight (lbs)
4. Rt. Leg (lbs)
5. Lt. Leg (lbs)
6. Tot. leg (lbs)
7. Stair power (secs)
8. Stair power (kgm/sec)
9. Vert. Jump (ins)
10. Vert. Jump (ft. lbs)
11. FIS Downhill (pts)
12. FIS Slalom (pts)
13. FIS Giant Slalom (pts)